

CLAIMS

1 1. A method of creating multiple spanning trees within a computer network, each
2 spanning tree defining a loop-free path among a plurality of intermediate devices within
3 the network, the network configured with a plurality of virtual local area network
4 (VLAN) designations, the method comprising the steps of:

5 receiving a plurality of multiple instance spanning tree protocol bridge protocol
6 data unit (MI-STP BPDU) messages at one or more of the intermediate devices from re-
7 maining ones of the intermediate devices, each MI-STP BPDU containing a spanning tree
8 instance identifier;

9 processing the received MI-STP BPDU messages at the one or more intermediate
10 devices so as to define a loop-free path for each spanning tree instance identifier;

11 mapping each VLAN designation of the computer network to a spanning tree in-
12 stance identifier; and

13 distributing messages tagged with a given VLAN designation across the loop-free
14 path for the spanning tree instance identifier to which the given VLAN designation is
15 mapped.

1 2. The method of claim 1 further comprising the step of configuring one or more
2 intermediate devices with the spanning tree instance identifiers for the computer network.

1 3. The method of claim 1 further comprising the step of configuring one or more
2 intermediate devices with the mapping of VLAN designations to spanning tree instance
3 identifiers.

1 4. The method of claim 3 wherein the step of configuring is performed by a
2 VLAN distribution protocol.

1 5. The method of claim 4 wherein the VLAN distribution protocol is the VLAN
2 Trunk Protocol (VTP).

1 6. The method of claim 1 wherein the step of processing received MI-STP BPDU
2 messages comprises the steps of:

3 electing a root device for each spanning tree instance;

4 identifying a root port at each intermediate device for each spanning tree instance,
5 each root port providing a lowest cost path to the root device of the respective spanning
6 tree instance;

7 identifying zero, one or more designated ports at each intermediate device for
8 each spanning tree instance; and

9 transitioning the root port and each designated port for each spanning tree in-
10 stance at the intermediate devices to a forwarding spanning tree port state.

1 7. The method of claim 6 further comprising the step of transitioning all non-root
2 and non-designated ports for each spanning tree instance to a blocking spanning tree port
3 state.

1 8. The method of claim 7 further comprising the step of, in response to receiving a
2 conventional configuration BPDU message at a given intermediate device, forwarding
3 the conventional configuration BPDU message from all designated ports of the interme-
4 diate device for a selected spanning tree instance.

1 9. The method of claim 1 wherein at least one MI-STP BPDU message for a given
2 spanning tree instance has a VLAN mapping message unit that includes each VLAN
3 designation mapped to the given spanning tree instance.
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1 10. The method of claim 1 wherein each MI-STP BPDU message includes a des-
2 tination service access point (DSAP) that contains a value other than the DSAP value
3 specified in the IEEE 802.1D standard for configuration BPDU messages so that MI-STP
4 BPDU messages received by legacy intermediate devices are dropped and not processed.

1 11. The method of claim 1 further comprising the step of blocking traffic associ-
2 ated with a VLAN designation that is mapped to more than one spanning tree instance.

1 12. The method of claim 1 further comprising the steps of waiting a preselected
2 time before distributing messages tagged with a given VLAN designation to confirm that
3 the VLAN mapping is correct.

1 13. The method of claim 12 wherein the VLAN mapping is considered correctly
2 mapped provided that no MI-STP BPDUs are received within the preselected time that
3 map the given VLAN designation to either a different spanning tree instance identifier or
4 to no spanning tree instance identifier.

1 14. The method of claim 12 wherein the preselected time is a forward delay time
2 specified in the MI-STP BPDU.

1 15. The method of claim 1 further comprising the step of tunneling un-tagged
2 IEEE bridge protocol data unit (BPDU) messages utilizing the loop-free path of a pre-
3 lected spanning tree instance identifier.

1 16. The method of claim 15 wherein the step of tunneling comprises the step of
2 forwarding the IEEE BPDU message unmodified from each intermediate device port that
3 is in the forwarding state for the preselected spanning tree instance identifier other than
4 the port on which the IEEE BPDU message was received.

1 17. The method of claim 16 further comprising the steps of:
2 examining a topology change (TC) flag of IEEE BPDU messages received at a
3 given intermediate device; and
4 for each spanning tree instance for which the given intermediate device is the
5 root, setting a TC flag of the MI-STP BPDU messages sourced by the given intermediate
6 device as the root.

1 18. The method of claim 15 further comprising the step of tunneling un-tagged
2 IEEE Topology Change Notification (TCN) messages utilizing the loop-free path of the
3 preselected spanning tree instance identifier.

1 19. The method of claim 1 further comprising the step of tunneling BPDU mes-
2 sages that are tagged with a given VLAN designation along the loop-free path established
3 for the spanning tree instance to which the given VLAN designation is mapped.

1 20. The method of claim 19 further comprising the steps of:
2 examining a topology change (TC) flag of BPDU messages tagged with a VLAN
3 designated and received at a given intermediate device; and
4 provided that the given intermediate device is the root for the spanning tree in-
5 stance to which the VLAN of the BPDU message is mapped, setting a TC flag of the MI-
6 STP BPDU messages sourced by the given intermediate device the spanning tree in-
7 stance.

1 21. The method of claim 19 further comprising the step of tunneling IEEE Topol-
2 ogy Change Notification (TCN) messages tagged with the given VLAN designation
3 along the loop-free path established for the spanning tree instance to which the given
4 VLAN designation is mapped.

1 22. An intermediate device for use in a computer network having a plurality of
2 virtual local area network (VLAN) designations, the intermediate device comprising:
3 a plurality of ports for use in interconnecting the intermediate device to the com-
4 puter network;
5 a spanning tree engine in communicating relationship with the plurality of ports,
6 wherein the spanning tree engine is configured to:
7 generate and send from the plurality of ports one or more multiple instance
8 spanning tree protocol bridge protocol data unit (MI-STP BPDU) messages, each
9 MI-STP BPDU containing a spanning tree instance identifier; and

10 process received MI-STP BPDU message so as to cooperate in establish-
11 ing a loop-free path for each spanning tree instance identifier; and
12 a VLAN association engine for mapping each VLAN designation to a spanning
13 tree instance identifier so that messages tagged with a given VLAN designation may be
14 forwarded along the loop-free path established for the spanning tree instance identifier to
15 which the given VLAN designation is mapped.

1 23. The intermediate device of claim 22 further comprising at least one memory
2 structure configured to store the mapping of VLAN designations to spanning tree in-
3 stances.

1 24. The intermediate device of claim 23 further comprising a plurality of state
2 machines, each state machine associated with a spanning tree instance and configured to
3 transition the ports of the device among a plurality of spanning tree port states, including
4 a blocking, a listening, a learning and a forwarding spanning tree port state, in response to
5 the processing of received MI-STP BPDU messages by the spanning tree engine.

1 25. The intermediate device of claim 23 further comprising means for blocking
2 messages tagged with a given VLAN designation upon determining that the given VLAN
3 is mapped to zero or more than one spanning tree instance.

1 26. A computer readable medium containing executable program instructions for
2 creating multiple spanning trees within a computer network, each spanning tree defining
3 a loop-free path among a plurality of intermediate devices within the network, the net-
4 work configured with a plurality of virtual local area network (VLAN) designations, the
5 executable program instructions comprising steps for:

6 processing received multiple instance spanning tree protocol bridge protocol data
7 unit (MI-STP BPDU) messages, each MI-STP BPDU containing a spanning tree instance
8 identifier, so as to define a loop-free path for each spanning tree instance identifier;
9 mapping each VLAN designation of the computer network to a spanning tree in-
10 stance identifier; and

27. An intermediate device for use in a computer network having a plurality of virtual local area network (VLAN) designations, the intermediate device comprising:

- a plurality of ports for use in interconnecting the intermediate device to the computer network;
- means for generating and sending from the plurality of ports one or more multiple instance spanning tree protocol bridge protocol data unit (MI-STP BPDU) messages, each MI-STP BPDU containing a spanning tree instance identifier;
- means for processing received MI-STP BPDU message so to transition the ports among a plurality of spanning tree port states, including blocking, listening, learning and forwarding states, for each spanning tree instance;
- means for mapping each VLAN designation to a spanning tree instance identifier;
- and
- means for forwarding messages tagged with a given VLAN designation from ports in the forwarding spanning tree port state for the spanning tree instance to which the given VLAN designation is mapped.